INSTRUCTION MANUAL

MODEL T279

CIRCUIT TERMINATION SET

wilcom

WILCOM PRODUCTS INC.
P.O. BOX 508
LACONIA N.H. 03246
PHONE: 603 524 2622
TWX: 510-298-1120

Electronic Services - Los Angel
M16771X

MODEL T279
CIRCUIT TERMINATION SET

WARRANTY

ALL WILCOM products are warranted against defects in materials and workmanship. This warranty applies for a period of one year from date of delivery, except in specialized cases where a different period may be specified for particular items.

WILCOM'S obligation under this warranty is limited to servicing or adjusting each instrument returned to its factory within the warranty period, and to replace any components which are found to be defective. If in WILCOM'S judgement the defective condition is a result of misuse or abnormal operation, repairs will be billed.

If faulty conditions develop, notify WILCOM for instructions. Servicing information will be supplied wherever possible. If the equipment is to be returned for repairs, please include a description of the faulty condition and who should be contacted if additional information is needed. Ship the equipment prepaid.

PROPRIETARY INFORMATION

The information contained in this manual is the proprietary material of Wilcom Products, Inc., and may not be reproduced, used for manufacturing purposes, or disclosed to others for any use without permission from Wilcom Products, Inc.

CONTENTS

SECTION	TITLE	PAGE
1	General	1
	1.1 Description of Features	1
2	Description of Apparatus	5
	2.1 Connection and Controls	5
3	Specifications	9
4	Operation	11
	4.1 Connections and Controls	11
5	Applications	13
	5.1 General	13
	5.2 Isolating the C.O.	13
	5.3 Isolating Unbalanced C.O. Equipment	13
	5.4 Sectionalizing Cable	17
	5.5 Stabilizing Power Influence	21
6	Maintenance and Repair	22
	6.1 General	23
	6.2 Parts List	24
Appendix: Balance		25

FIGURES

Fig. 1	Front Panel View Controls Designations	2
2	Schematic Diagram	7
3	Longitudinal Current Test Schematic	10
4	Isolating the C.O.	12
5	Isolating Unbalanced C.O. Equipment	14
6	C.O. Equipment Balance Measurements	16
7	Sectionalizing Cable	18
8	Stabilizing Power Influence	22

WILCOM T279 - CIRCUIT TERMINATION SET

1.0 GENERAL

1.1 Description of Features

1.1.01 The T279 is a balanced, switchable termination. When an investigation is made of noise conditions on a circuit, it is frequently desirable to obtain noise and circuit balance measurements on selected sections of the circuit. This termination facilitates sectionalizing by providing a balanced longitudinal circuit termination consisting of a well balanced center tapped coil to provide means for maintaining the longitudinal circuit. In addition, it contains an appropriate terminating resistor in order to terminate the metallic circuit at that point. The desired termination can be obtained by switching (see figure 1). In other words, longitudinal influence can be coupled through the termination while terminating the metallic circuit at that point. This facilitates obtaining circuit balance information from the longitudinal and metallic noise data taken using a circuit measuring set.

1.1.02 The T279 in conjunction with the T136 circuit measuring set also can be used to measure central office equipment balance.

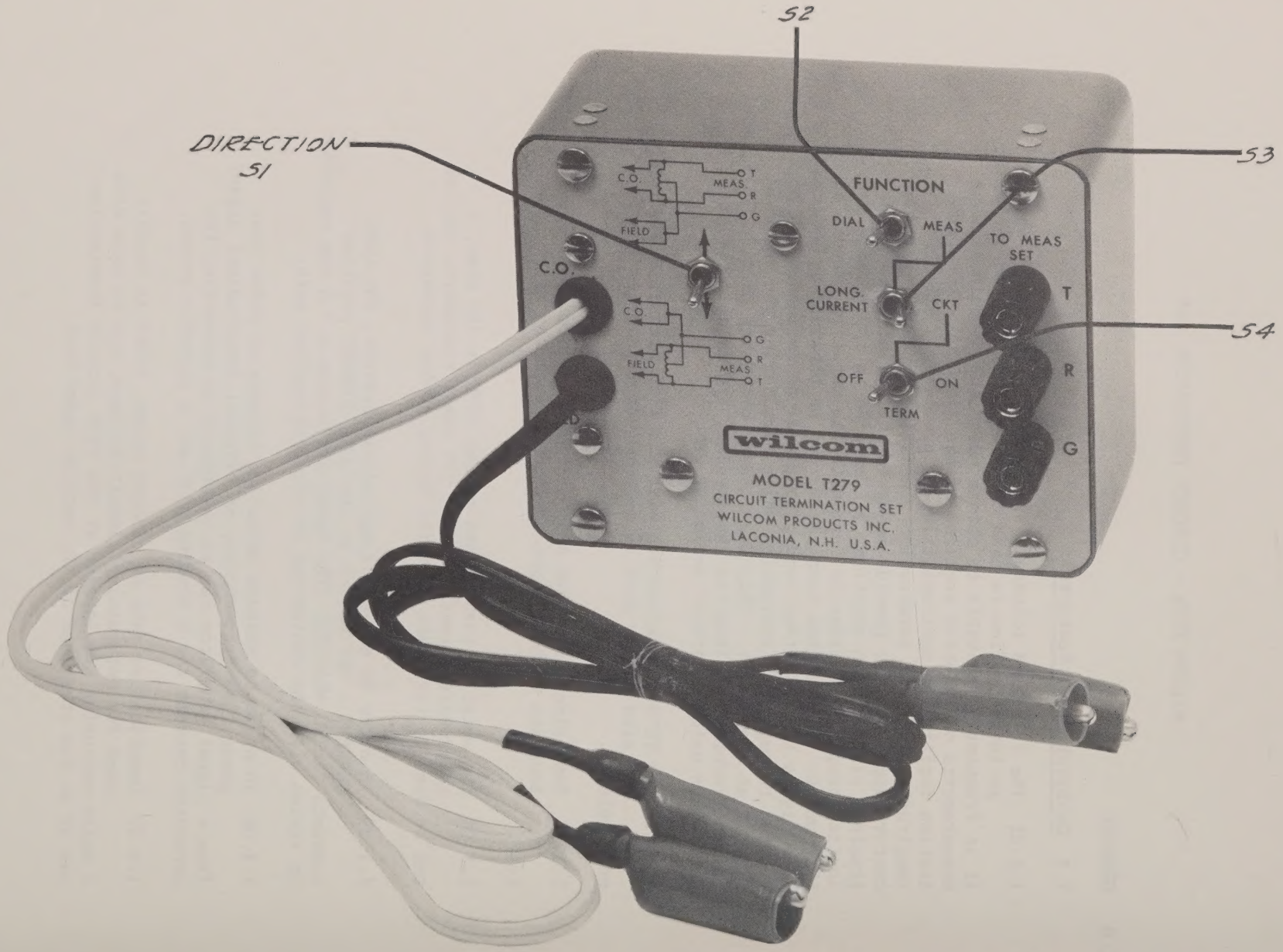
1.1.03 Provisions have been made for dialing from the T279 location without removing the set from the line under test.

1.1.04 The metallic termination of the T279 is 750 ohms, a compromise between 600 and 900 ohms; therefore, the set can be used to terminate circuits having either impedance.

1.1.05 In order to measure longitudinal current, the LONG CURRENT - CKT switch in the LONG CURRENT position connects the TO MEAS SET (TR) terminals across a 7.5 ohm resistor in series with the center tap of the longitudinal path.

1.1.06 In order to measure noise and balance at other than power line frequencies, an external longitudinal signal from a signal generator can be introduced by connecting the generator between the G binding post and a suitable ground.

1.1.07 Quantitative data on circuit noise, which is usually used for determining circuit balance, can be made with a noise measuring set located at the T279 circuit termination set or at the other end of the section under test.



FRONT PANEL VIEW

Fig. 1

1.1.08 Headphones may be connected to the TO MEAS SET (TR) binding posts to quickly determine which section is moisy before making quantitative tests.

1.1.09 Figure 1 indicates the major controls. Figure 2 is a complete schematic of the T279 Circuit Termination Set.

1.1.10 The model T279K is an option of the model T279 consisting of a T279 mounted in the cover of a T136 Circuit Measuring Set. This combination is very convenient for installers and repairpersons when locating conditions that generate noise by enabling them to terminate and measure sections of a circuit using a single portable compact combination test set.

1.1.11 Model T279K-1 is hinged on the side; model T279K-2 is hinged on the top.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07053

2.0 DESCRIPTION OF APPARATUS

2.1 Connections and Controls

2.1.01 The Model T279 includes a balanced center tapped coil, a terminating resistor, and a toggle switch (S1) that connects the coil across either of two pairs of clip leads labeled FIELD an C.O. Measurements are made across a pair of binding post terminals labeled TO MEAS SET (TR). S1, the FIELD-C.O. toggle switch, is used to select the direction in which measurement is made. (See the front panel schematic illustration). The arrangement is such that the line in the direction not being measured is shorted and connected to the coil center tap to maintain the longitudinal path.

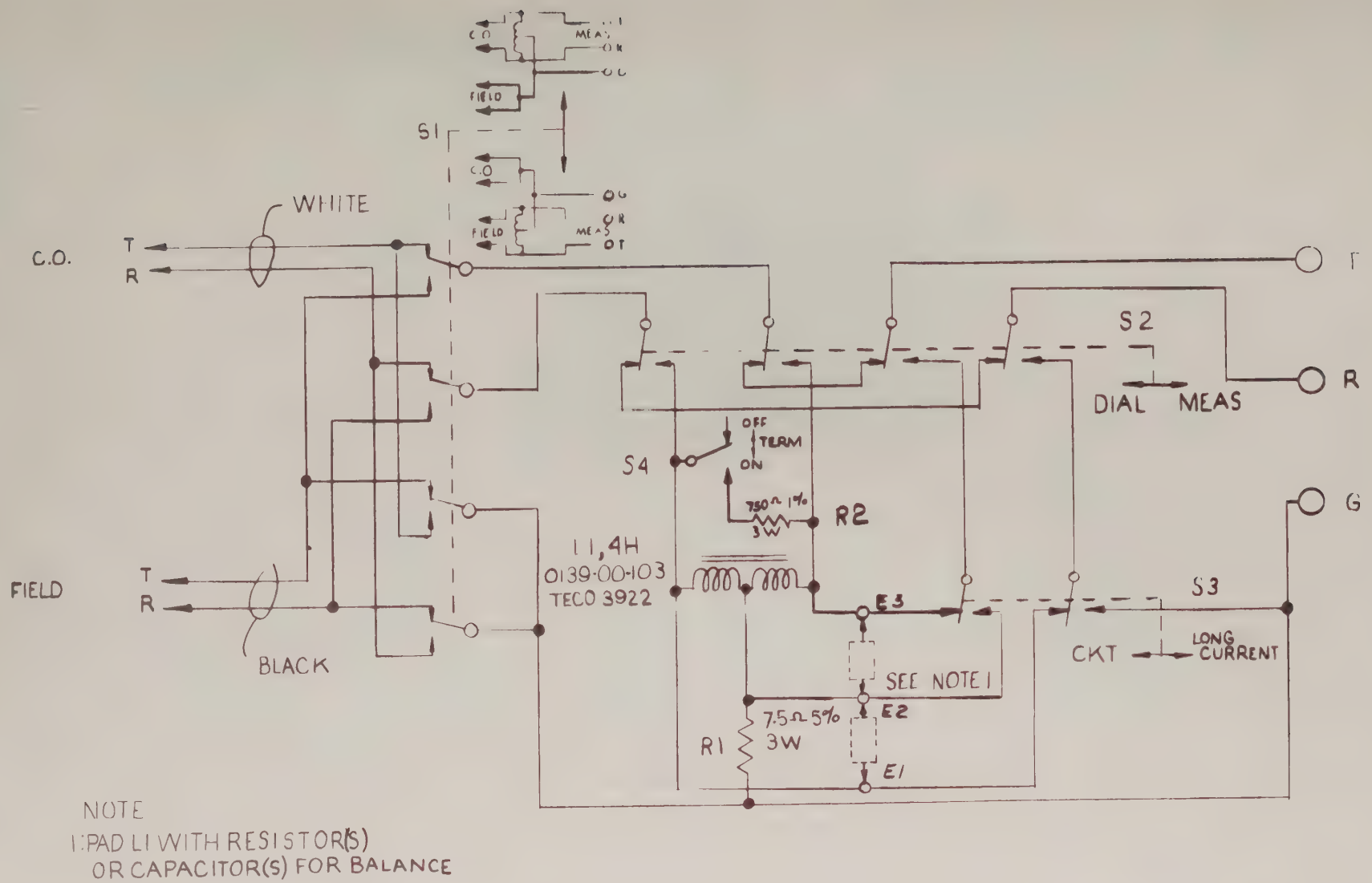
2.1.02 A group of three toggle switches (figure 1) provides the following functions:

S2, A DIAL-MEAS switch. In the DIAL postion this switch connects the TO MEAS SET (TR) terminals directly to the selected direction, C.O. or FIELD. To obtain the circuit as determined by the LONG. CURRENT-CKT switch, the DIAL MEAS switch must be in the MEAS position.

S3, A LONG CURRENT - CKT switch. In the CKT position this switch connects the TO MEAS SET terminals across the coil and line. In the LONG. CURRENT position the TO MEAS SET terminals are connected across a 7.5 ohm resistor in series with the longitudinal path.

S4, A TERM switch. In the ON positon the TERM switch connects a 750 ohm terminating resistor across the balance coil.

2.1.03 The binding post marked G provides a means for connecting to the center tap of the coil. This terminal should remain unconnected during most measurements.



Schematic Diagram
Fig. 2

3.0 SPECIFICATIONS

Balance Coil:

4H, 400 ohms, center tapped
Max dc current 100 mA
Balance: 70 dB min, 300 Hz to 3 kHz with zero to 80 mA dc, measured in accordance with IEEE Std 455-1976 at MEAS SET terminals (T,R,G,), FUNCTION switches in MEAS., CKT., and TERM ON positions, direction switch in either position.

Termination:

750 ohms, 3 watts

Longitudinal Resistance:

107 ohms

Longitudinal Current:

MEAS SET is connected across 7.50 ohm resistor in series with Longitudinal path.

Controls:

Direction toggle switch for measuring toward C.O. or toward Field.
3 FUNCTION toggle switches:
DIAL-MEAS
LONG. CURRENT - CKT.
TERM ON-OFF

Size:

3 3/4"W x 5 1/4"L x 2 3/4"H (including terminals).

Weight:

1 1/4 lbs.

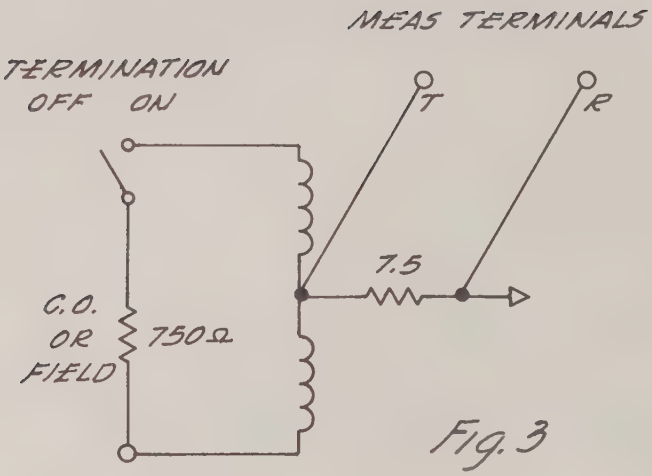


Fig. 3

LONGITUDINAL CURRENT TEST

4.0 OPERATION

4.1 General - Connections and Controls

4.1.01 At intermediate points on the circuit under test, the facilities are attached to the T279 by way of connecting cords terminated in alligator clips.

4.1.02 If a ground must be provided for the G terminal, an earth ground is preferred. Once the termination is attached to the circuit, the type of termination desired can be obtained by properly positioning the toggle switches. The function of these switches are described below.

4.1.03 The toggle switch, S1, is used to select the direction in which the balanced coil is facing, either towards the C.O. or towards the FIELD. The schematic on the front panel of the T279 illustrates the selected termination.

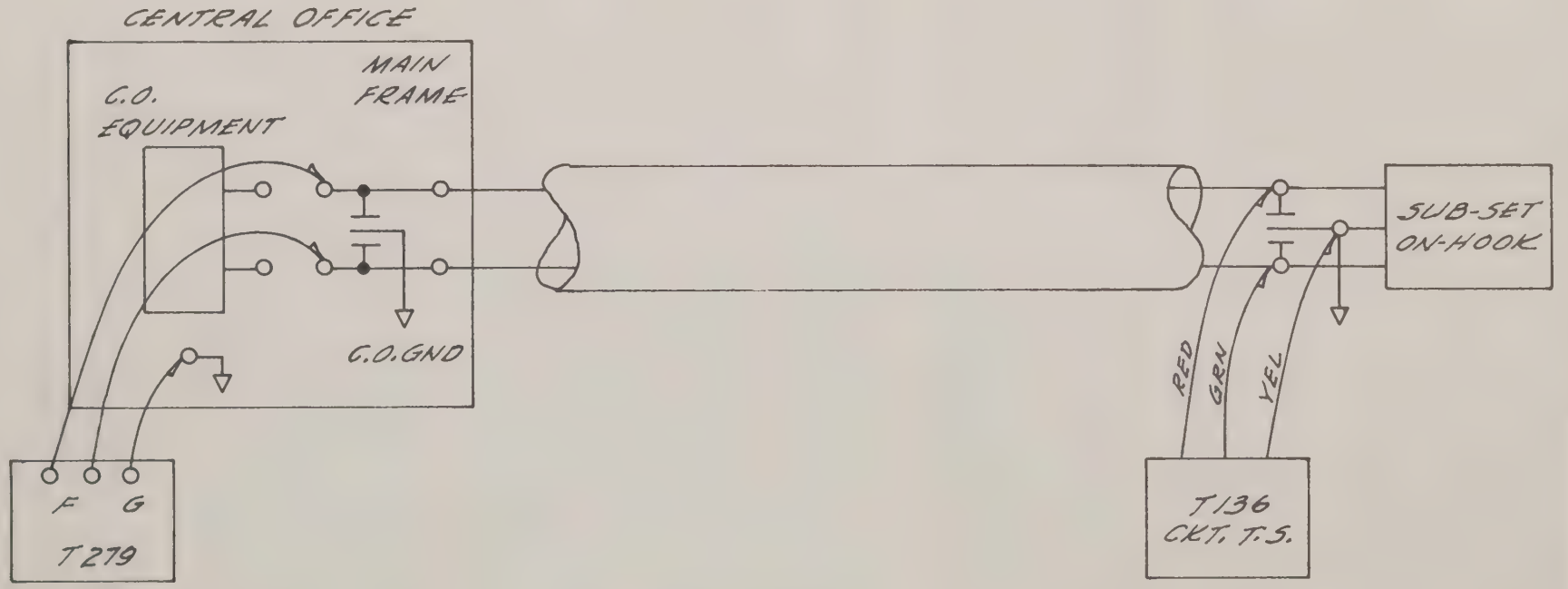
4.1.04 The position of the TERM; ON, OFF switch (S4) determines if the resistive termination is ON or OFF. This resistor terminates the metallic circuit when the switch is in the TERM, ON position.

4.1.05 The DIAL - MEAS switch (S2) facilitates dialing from the T279 location. The switch must be placed in the DIAL position and the leads of the lineman's telephone handset connected to the TO MEAS SET (TR) terminals for dialing. Or, if a WILCOM T136 Circuit Measuring Set is being used with the T279, the GRN-T and RED-R leads of the T136 can be connected to the TO MEAS SET (TR) terminals of the T279 and the lineman's telephone connected to the DIAL terminals of the T136. With the latter set up the T136 and the telephone are both in position ready for use. The function will be determined by the combined positions of the function switches on both sets. It should be noted that the DIAL - MEAS switch of the T279 should always be in the MEAS position unless dialing; otherwise, the line under test is not properly terminated and the test data will be invalid. (The DIAL - MEAS switch in the MEAS position places the balance coil and/or resistive termination in the circuit).

4.1.06 The binding posts identified as TO MEAS SET (TR) are bridged across the balance coil when switch S3 is in the CKT position and switch S2 is in the MEAS position. These are the same terminals to which the resistive termination is attached by the placement of switch S4 in the TERM ON position. If a WILCOM T136 Circuit Measuring Set is used to measure circuit noise (noise metallic) at the same location that a T279 Circuit Termination Set is being used, the T279 switch S4 should be in the TERM OFF position to avoid a double termination.

4.1.07 The LONG. CURRENT-CKT switch (S3) is used for measuring trunk equipment unbalances, and subscriber loops in or near the central office. See Section 5.4 "Sectionalizing Cable". When this switch is in the LONG. CURRENT position, the TO MEAS SET (T,R) terminals are connected across the 7.5 ohm resistor in the center tap of the 4 henry coil. Refer to Fig. 3 for a schematic of the T279 with the LONG. CURRENT TEST switch ON.

ISOLATING THE CENTRAL OFFICE



T-279 SWITCH POSITIONS

S1, DOWN, COIL TO THE FIELD
S2, DIAL-MEAS, MEAS POSITION
S3, LONG CURRENT-CKT, CKT POSITION
S4, TERM ON

T-136 MEASUREMENTS

MEASURE —— PWR INFL
MEASURE —— CKT NOISE
DETERMINE —— BALANCE

FIG. 4

5.0 APPLICATIONS

5.1 General

5.1.01 Noise investigations many times require that the facilities be sectionalized in an attempt to isolate the source of noise. This subsection will describe some of the applications of the T279 Circuit Termination Set when used with Model T136 Circuit Test Set in noise investigation work.

5.2 Isolating the Central Office

5.2.01 After measuring noise at the subscriber premise and determining that Power Influence, Circuit Noise or Balance requirements cannot be met, an investigation should be initiated to determine the cause. The first step should be to isolate the central office (C.O.) as a source of noise or unbalance using the T279 Set. Figure 4 diagrams the method used, the procedure below should be followed:

a. Contact a C.O. Test Person to make the following connections with a T279 Termination Set.

b. Connect the black test cord designated FIELD to the Cable side of the main frame.

c. Connect the G binding post (or both alligator clips of the white test cord designated C.O.) to the C.O. ground bus.

d. Open the Office side of the pair being tested at the main frame. Remove the heat coils or indent the protection module.

e. Set Switch S1 on the T279 towards the lower schematic (the balance coil to the FIELD).

f. Set Switch S4 to the TERM ON position.

g. Set the LONG CURRENT switch to CKT.

h. Set the DIAL - MEAS Switch TO MEAS.

5.2.02 Noise Measurements at the subscriber premise can now be repeated. All C.O. equipment is isolated from the pair under test. A significant improvement in noise or balance, when compared to noise and balance measurements made to a QUIET termination, would indicate that the C.O. is contributing to the noise or is badly unbalanced.

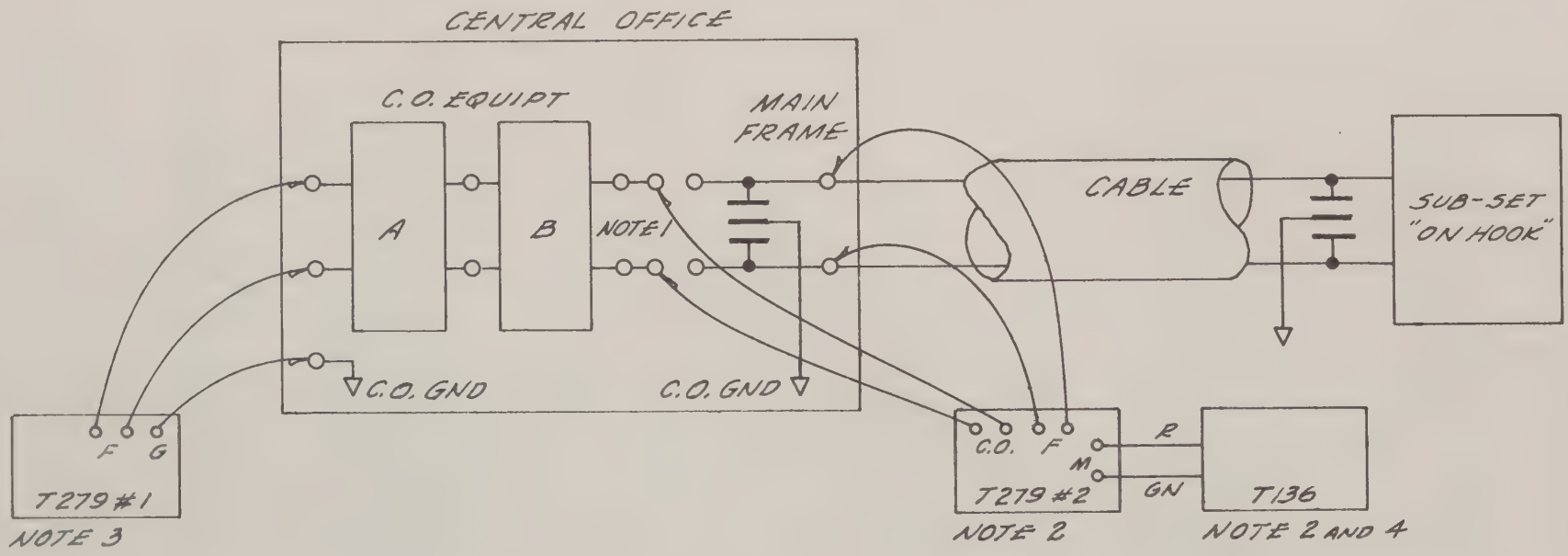
5.3 Isolating Unbalanced C.O. Equipment

5.3.01 If the measurements indicate unbalance in the C.O. equipment, further measurements can be made to identify the equipment that is unbalanced. Two methods can be used and are described below.

5.3.02 In-Circuit Balance Measurements - Figure 5 illustrates the method involved in making measurements to isolate poorly balanced C.O. equipment. Two T279 circuit termination sets are required. Connect the first T279 as follows:

1. Connect the FIELD test cord (black) to the input of the

ISOLATING UNBALANCED C.O. EQUIPMENT



T279 #1 SWITCH POSITIONS

TERM ——— ON
LONG. CURRENT-CKT — CKT
DIAL-MEAS ——— MEAS
DIRECTION ——— FIELD (DOWN)

T279 #2 SWITCH POSITIONS

TERM ——— OFF
LONG. CURRENT-CKT — CKT (FOR CKT NOISE)
— LONG. CURRENT (FOR LONG CURRENT)
DIRECTION ——— C.O. (UP)

T136 MEASUREMENTS

MEASURE —— LONG. CURRENT NOTE 4
MEASURE —— CKT NOISE
DETERMINE — BALANCE

BALANCE = NOISE LONGITUDINAL - CKT NOISE
(NOISE LONGITUDINAL = LONG. CURRENT READING + 40 dB)

NOTES:

1- REMOVE HEAT COILS.
2- GND NOT REQUIRED.
3- THIS CAN BE THE C.O. QUIET TERM.
4- T136 FUNCTION SWITCH ON CKT NOISE. ADD 40 dB TO GET NOISE LONGITUDINAL
5- DETERMINE BALANCE AS EACH PIECE OF C.O. EQUIPMENT IS REMOVED FROM CIRCUIT, SEE PARAGRAPH 5.3. IF NECESSARY TO STABILIZE POWER INFLUENCE SEE PARAGRAPH 5.5.

FIG. 5

C.O. equipment furthest from the amin frame (electrically).

2. Connect the G binding post to the C.O. ground.

3. Set Switch S1 to the lower schematic (the balance coil to the FIELD).

4. Set Switch S4 to TERM ON position.

5. Set the LONG. CURRENT-CKT switch S3 to CKT.

6. Set the DIAL- MEAS switch to MEAS.

7. Remove the heat coils from the circuit under test.

Connect the T279 Circuit Termination Set #2 as follows:

1. Connect the FIELD (black test cords) of the T279 to the cable pair at the main frame.

2. Connect the C.O. (white test cords) to the C.O. equipment side of the frame.

3. Connect the RED and GREEN leads of the T136 to the TO MEAS SET binding posts of the T279 #2. Set the FUNCTION switch of the T136 to CKT NOISE.

4. Set switch S1 to the C.O. (up) position.

5. Set the TERM switch to OFF.

6. Set the LONG. CURRENT-CKT switch to LONG. CURRENT.

7. Set the DIAL-MEAS switch to MEAS.

8. Read the T136 (operate the ADD 20 button if necessary). Add 40 dB to reading and record as NOISE LONGITUDINAL.
   NOTE: NOISE LONGITUDINAL is the LONG. CURRENT measurement plus 40.

9. Set the LONG. CURRENT-CKT switch to CKT on the T279 #2.

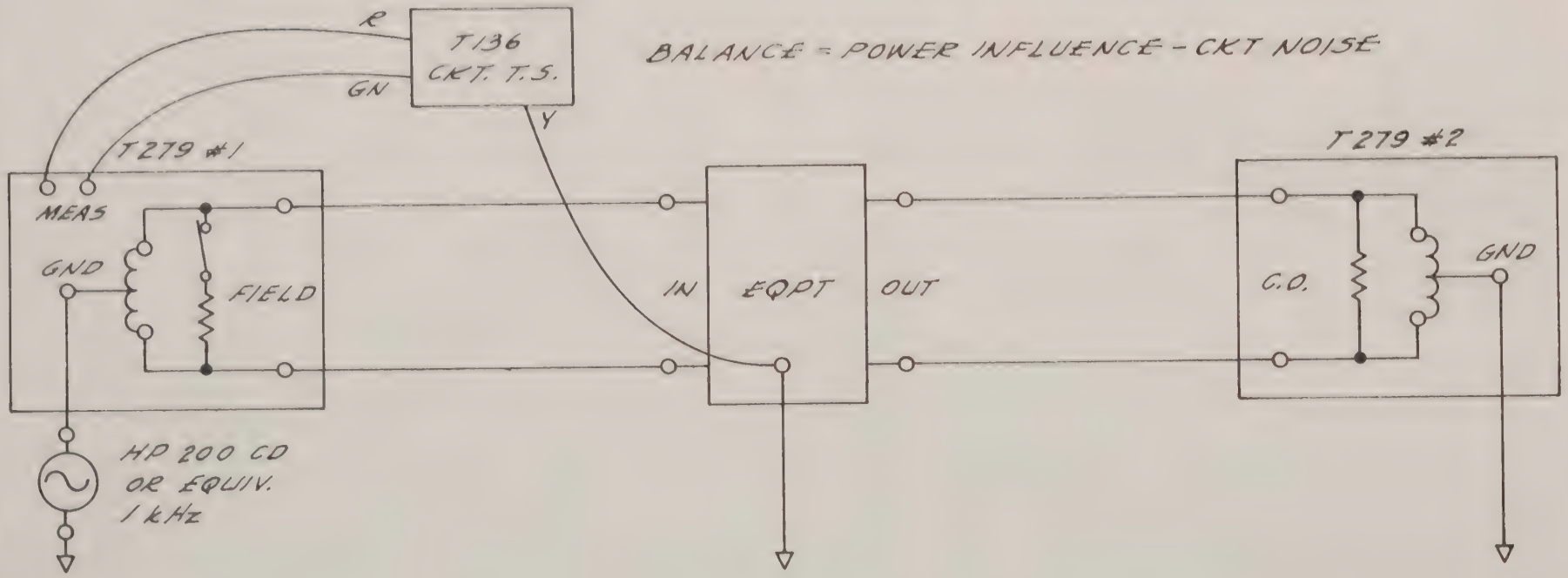
10. Read the T136 (operate the ADD 20 button if necessary). Record this reading as CKT NOISE.

11. BALANCE = NOISE LONGITUDINAL - CKT NOISE.
    NOTE: BALANCE is discussed in more detail in the Appendix.

5.3.03 Progressively move the first T279B Circuit Termination Set towards the main frame, determining the BALANCE each time a piece of C.O. equipment is removed from the circuit. Any significant improvement in BALANCE after removal of a piece of equipment indicates poor balance in that equipment.

5.3.04 Individual C.O. Equipment Balance Measurements:
It may be desireable to measure the balance on an individual piece of equipment that appeared to be bad in subsection 5.3.03, or on a piece of equipment before it is placed in service. Accurate balance measurements,

Measuring The Balance Of C.O. Equipment



T279 #1 SWITCH POSITIONS

TERM	ON
LONG. CURRENT-CKT	CKT
DIAL-MEAS	MEAS
DIRECTION	FIELD (DOWN)

T279 #2 SWITCH POSITIONS

TERM	ON
LONG. CURRENT	CKT
DIAL-MEAS	MEAS
DIRECTION	C.O. (UP)

NOTE: BE SURE THAT ALL GND CONNECTIONS ARE COMMON. KEEP EQUIPMENT CONNECTIONS SHORT.

Fig. 6

suitable for making comparisons among similar equipments, should be made using an instrument such as the Wilcom Model T207 Longitudinal Balance Test Set. which is designed to make measurements in accordance with IEE STD 455 - 1976 Standard Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band. However, an approximate balance measurement, useful for identifying faulty equipment, can be made using two T137B Circuit Terminating Sets, an oscillator, and a T136 Circuit Test Set. The method of making this measurement is shown in Figure 6. Referring to Figure 6, proceed as follows:

1. Connect the C.O. (white test cords) of T279 #2 to one port of the piece of equipment under test. Designate these terminals OUT.

2. Connect the G binding post to ground.

3. Operate the TERM switch (S4) to ON.

4. Operate the LONG. CURRENT-CKT switch (S3) to CKT.

5. Operate the DIAL - MEAS switch to MEAS.

6. Set switch S1 to C.O. (UP).

7. Connect the FIELD (black test cords) of the T279 #1 to the other port of the piece of equipment under test. Designate these terminals IN.

8. Connect the RED and GREEN leads of the T136 to the TO MEAS SET binding posts of T279 #1.

9. Operate the TERM switch to ON.

10. Operate the DIAL-MEAS switch to MEAS.

11. Set switch S1 to FIELD (down).

12. Set the FUNCTION switch of the T136 to PWR INFL.

13. Connect the G binding post to one terminal of the oscillator. Earth ground the other terminal of the oscillator. Adjust the output of the oscillator until the T136 reads 90 dBrnc at 1000 Hz. Record this reading as POWER INFLUENCE.

14. Set the FUNCTION switch of the T136 to CKT NOISE.

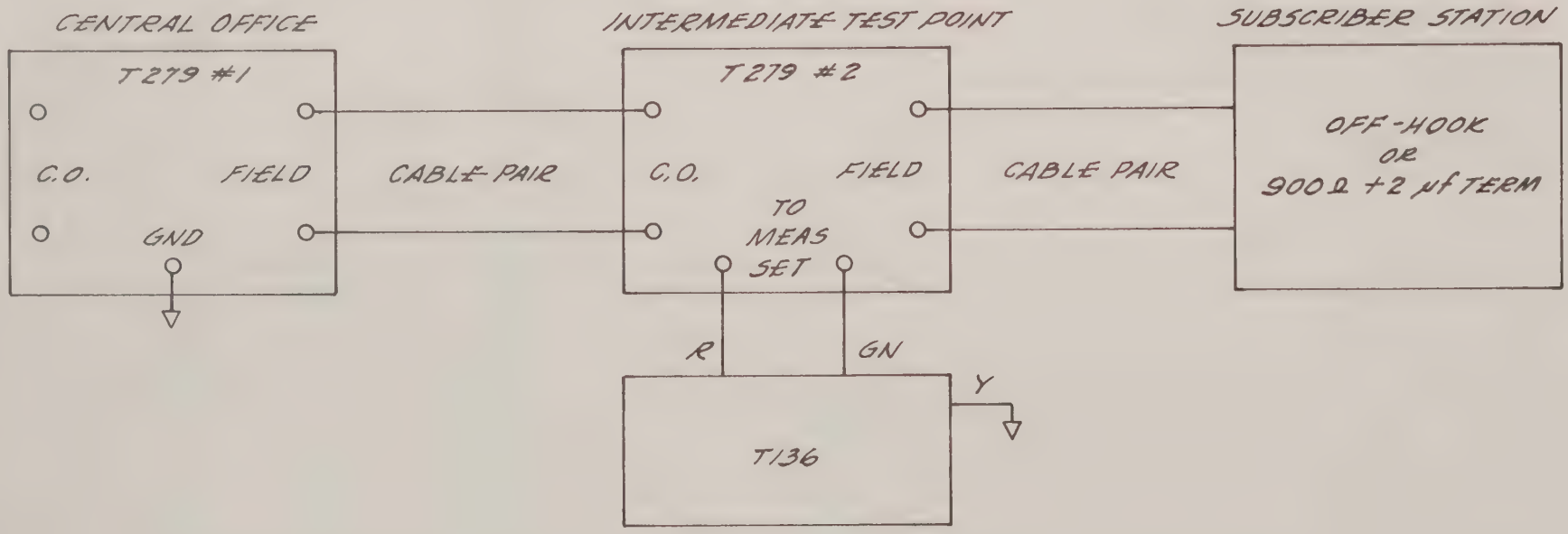
15. Read the T136 and record this reading as CKT NOISE.

16. BALANCE = POWER INFLUENCE - CKT NOISE.

5.4 Sectionalizing Cable

5.4.01 If the tests performed in sub-section 5.2, Isolating the Central Office, indicate that the source of noise or unbalance is in the cable and not in the Central Office, steps should be taken to sectionalize the cable and isolate the noise or unbalance to a particular section of cable. This sub-section will describe the use of the T279 Circuit Termination Set and the methods used in sectionalizing cable. Figure 7 illustrates the procedure used to isolate the section of cable having severe exposure

SECTIONALIZING CABLE



T279 #1 SWITCH POSITIONS

TERM ——— ON
LONG. CURRENT-CKT ——— CKT
DIAL-MEAS ——— MEAS
DIRECTION ——— FIELD (DOWN)

T279 #2 SWITCH POSITIONS

TERM ——— OFF
LONG CURRENT-CKT ——— CKT (FOR CKT NOISE OR POWER INFL)
——— LONG CURRENT (NOISE LONGITUDINAL)
DIRECTION ——— TOWARD FIELD (DOWN)
——— TOWARD C.O. (UP)
DIAL-MEAS ——— MEAS

FIG. 7

or unbalance problems. Referring to Figure 7 proceed as follows:

1. Remove the heat coils on the pair under test and connect the FIELD (black test cords) of T279 #1 to the cable pair. Connect the G binding post to ground.

2. Operate the TERM switch to ON.

3. Operate the LONG CURRENT-CKT switch to CKT.

4. Operate the DIAL-MEAS switch to MEAS.

5. Set switch S1 to FIELD (down).

6. Connect a 900 ohm resistor in series with a 2 uF capacitor across the TIP and RING terminals at the station protector. This has the advantage of not having to gain access to the subscriber's premises and allows the line to be in service as soon as the heat coils are replaced in the C.O. If the subscriber's station can be taken out of service, a T279 with termination switch ON and no ground connection to the coil center tap, may be used.

7. Select some location about half-way, between the C.O. and the station where there is easy access to the cable pair. Open the cable at this location.

8. Connect the C.O. (white test cords) of T279 #2 to the pair towards the C.O. and the FIELD (black test cords) to the pair towards the FIELD.

9. Connect the RED and GREEN leads of the T136 to the TO MEAS SET binding posts of T279 #2 and the YELLOW lead to ground.

10. Set the TERM switch to OFF and the DIAL-MEAS switch to MEAS. Leave these switches in these positions for the remainder of these tests.

11. Set the T279 (2) switch to FIELD (down).

12. Operate the T279 (2) LONG. CURRENT-CKT switch to LONG. CURRENT.

13. Set the T136 FUNCTION switch to CKT NOISE.

14. Read the T136 ; add 40 to the reading and record as NOISE LONGITUDINAL.

15. Set the T279 (2) LONG. CURRENT-CKT switch to CKT.

16. Read the T136 and record the reading as CKT NOISE.

17. Set the T136 FUNCTION switch to PWR INFL.

18. Read the T136 and record the reading as PWR INFL.

19. Compare the NOISE LONGITUDINAL value of (14) with PWR INFL value of (18). Select the one that is largest.

20. Compute the balance towards the FIELD using the value selected in (19):

BALANCE = NOISE LONGITUDINAL - CKT NOISE

or

BALANCE = PWR INFL - CKT NOISE

21. To measure the balance towards the C.O. change the T279 #2 switch from FIELD (down) to C.O. (up) and repeat Steps (12) thru (19).

22. Compute the balance towards the C.O. using the appropriate equation from Step (20).

5.4.02 When the direction of the high noise or poor balance with relation to the mid-point of the cable has been determined from the tests of 5.4.01 it will probably be desireable to further sectionalize the noise or unbalance. This may be done by moving the test location to a point approximately half-way between the mid-point test location and the end of the cable in the direction in which the noise has been sectionalized. The procedures of sub-section 5.4.01 are then repeated at the new test location.

It is usually not productive to try to carry this procedure to sections of cable under one load section in length unless the noise or balance problem is concentrated in one or two places. Examples: Water in a short section (one or two hundred feet) of cable; a bridge tap with one side open; a wet or "leaky" terminal; etc.

In some cases it will be found that the noise will be about the same in both directions from the test location. This is more likely to occur when the exposure to the power system is uniform over the length of the cable and the harmonic content of the power system is uniform in this section.

Under these conditions each section should be handled separately and the balance improved in each section in order to improve the overall circuit noise.

In some cases, where the balance is found to be about equal in both directions from the test point, an improvement in overall circuit noise has been obtained by making a tip and ring reversal in the cable pair at the test point. If the POWER INFLUENCE or NOISE LONGITUDINAL measurements made in sub-section 5.4.01 are greater than 90 dBrnc it will be difficult to get satisfactory CIRCUIT NOISE results (20 dBrnc for urban areas and 26 dBrnc in suburban and rural areas). Under these conditions the cable shielding and harmonic content of the power system should be investigated. With power influence or noise longitudinal of 90 dBrnc it is necessary to have a cable pair balance of 64 dB to obtain the 26 dBrnc requirement for circuit noise in rural areas. It has been found that to obtain this high a balance on some pairs in some cables that it is necessary to "offset" or "cancel out" the capacity unbalance to ground and the series resistance unbalance by reversing the tip and ring conductors of the pair at intervals as determined by balance tests.

5.5 Stabilizing Power Influence

5.5.01 When making measurements to isolate sources of unbalance it is necessary that the power influence be of a high enough magnitude and sufficiently stable to allow measurements of CKT NOISE and PWR INFL by a craftsman in the field using the Wilcom Model T136 Circuit Test Set.

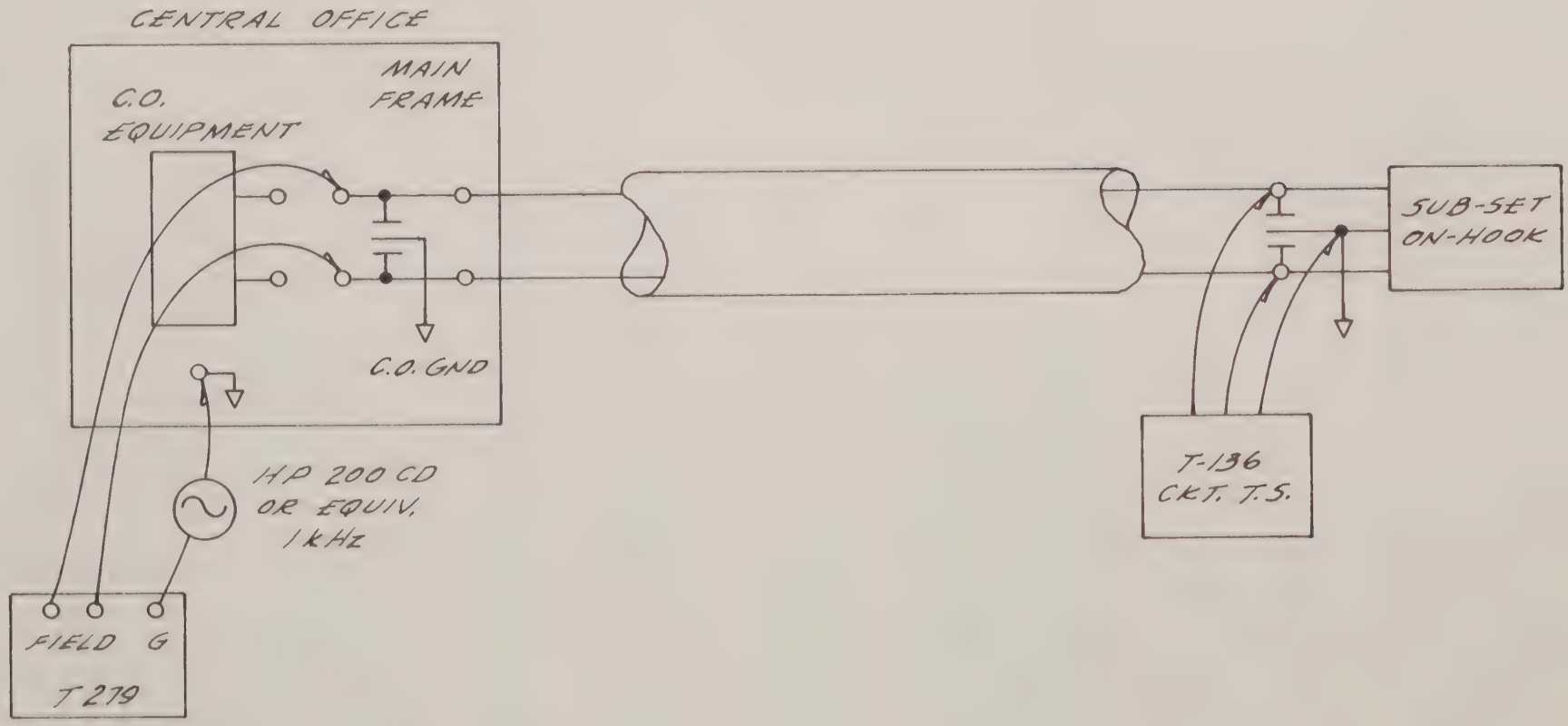
5.5.02 Many times it will be necessary to simulate longitudinal voltage because the actual voltage is extremely low or is unstable. The T279 Termination Set can be used in this application.

5.5.03 Figure 8 is an illustration of the test set-up used to stabilize power influence. This is basically the same set-up as used to check equipment balance as discussed in paragraph 5.3.04.

5.5.04 The output level of the oscillator should be adjusted for a PWR INFL level of 90 dBrn. CKT NOISE can then be measured. Occasionally the oscillator level will need readjustment to get both PWR INFL and CKT NOISE readings on scale. The circuit BALANCE can be derived from the following relationship:

BALANCE = PWR INFL - CKT NOISE

STABILIZING POWER INFLUENCE



T 279 SWITCH POSITIONS

TERM ——— ON
LONG CURRENT-CKT—CKT
DIAL-MEAS ——— MEAS
DIRECTION ——— FIELD (DOWN)

T136 MEASUREMENTS

MEASURE ——— PWR INFL
MEASURE ——— CKT NOISE
DETERMINE —— BALANCE

FIG. 8

6.0 MAINTENANCE AND REPAIR

6.1 General

6.1.01 The Model T279 Circuit Termination Set has no active components and is constructed of quality materials which should provide many years of trouble free service with normal use.

6.1.02 Should the T279 develop any trouble, simple dc resistance measurements will be needed to verify circuit continuity. The circuit schematic, Figure 2, will be helpful in making these measurements.

6.2 Parts List

6.2.01 The Parts List attached to this practice itemizes those replacement components that are available from Wilcom Products, Inc. or from the manufacturers.

PARTS LIST

MODEL T279 CIRCUIT TERMINATION SET

Ref Desig.	Description	Qty.	Mfr.	Manufacturer's Number
S1	SWITCH, Toggle 4PDT	1	Wilcom	0279-01-101
S2	SWITCH, Toggle 4PDT	2	Alco	MTA-406N
S3	SWITCH, Toggle DPDT	1	Alco	MTA-206N
S4	SWITCH, Toggle SPDT	1	Alco	MTA-106D
L1	INDUCTOR, Balanced (TECO 3922)	1	Wilcom	0139-00-103
R1	RESISTOR, 5%, 3W, 7.5 ohm	1	Ohmite	23J7R5
R2	RESISTOR, 1%, 3W, 750 ohm	1	Ohmite	82933

APPENDIX

Balance

Most telephone circuits are subject to the interfering effect of noise induction, mainly from adjacent power lines, which could render communication difficult if not impossible if it were not controlled. To minimize the effect, telephone circuits are balanced. A balanced circuit is made up of two branches which are electrically alike and symmetrical with respect to ground. The circuit in which the two sides consist of the two symmetrical branches is termed the Metallic Circuit, and is normal signal path. The circuit in which one side consists of the two symmetrical branches in parallel and the other side is a return through ground is termed the Longitudinal Circuit. If the circuit is perfectly balanced, the noise induction will be exactly equal in the two symmetrical branches and will produce no noise voltage or current in the metallic circuit. However, if there is any unbalance, the longitudinally induced noise will cause some noise to appear in the metallic circuit.

The degree of longitudinal balance, or simply the Balance, is defined as the ratio of disturbing longitudinal voltage, V_s, to the resulting metallic voltage, V_m, expressed in decibels:

$$\text{BALANCE} = 20 \text{ Log } \frac{V_s}{V_m} .$$

IEEE std 455 defines standard terminating impedances and means of applying a longitudinal test voltage, in a Standard Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band. For measuring balance in the field, it is generally more convenient to use the naturally existing longitudinal induction and resulting noise metallic, instead of applying a longitudinal test signal. A difficulty arises in measuring the value of induced longitudinal voltage, since the induction is usually distributed over a length of line and may not be available for measurement at any one point. Two methods for measuring the approximate value of balance using naturally occuring induction are in common use. One uses a measurement of noise-to-ground, or power influence, while the other requires a measurement of longitudinal current.

At any point on a telephone circuit, a voltage may be measured between ground and the two sides of the circuit taken together. This measurement is usually made with a c-message weighted noise measuring set, and expressed in dBrnc. It is termed the Noise-to-Ground (NG) or Power Influence (PWR INFL). If the measurement is made at a point remote from a central office, and if we assume that the impedance to ground is low at the CO and high at all other points, then the measured voltage to ground (PWR INFL) will be the actual induced longitudinal voltage. In this case, the balance in dB is equal to the noise-to-ground (or Power Influence) in dBrnc minus noise metallic (or Circuit Noise) in dBrnc.

$$\text{BALANCE} = \text{NG} - \text{NM}$$

In actual practice, there is a significant distributed impedance to ground, such as through cable capacitance, and as a result the measured voltage to ground may differ from the actual induced voltage. Still, the measurement of "balance" as NG - NM even though it may differ from the true balance, is easily obtained and provides a highly useful standard of acceptibility, and so it is in widespread use.

Close to a CO, the impedance to ground is generally low and only a small part of the induced longitudinal voltage appears as voltage to ground. The use of NG - NM as a balance figure would therefore be misleading. A line under test may be isolated from CO equipment without disturbing its normal noise induction condition by connecting it to a balanced inductor whose center tap is connected to CO ground. Now, if a small value resistor is inserted in the ground path, a measurement of voltage drop across the resistor will give an indication of the longitudinal current flow. From this, if we knew the total value of longitudinal circuit impedance, we could determine the induced longitudinal voltage. In practice, the longitudinal impedance of the line is assumed to be 750 ohms and a 7.5 ohm resistor is used in the ground path. If we measure voltage across the 7.5 ohm resistor and multiply by 100 (or add 40 dB) we get a value called "noise longitudinal" (NL) which is assumed to be the induced longitudinal voltage. Then, balance equals noise longitudinal - noise metallic.

$$\text{BALANCE} = \text{NL} - \text{NM}$$

This value may differ widely from the true balance, depending on the actual value of longitudinal impedance, but it is nevertheless useful in noise investigation. A better approximation to the true balance is obtained by measuring both NG - NM and NL - NM and using whichever value is higher.

NOTES

NOTES